# APPENDIX I
# TEMPERATURE FACTORS

## Introduction

Although not a listed pollutant on the 2006 303(d) list, temperature is an important water quality concern for the fisheries in the Prospect Creek watershed. Factors affecting temperature are discussed in other sections of this document: roads and utility corridors (**Appendix B**), stream flow and aggraded conditions as related to width-to-depth ratio (**Appendix F**) and riparian vegetation (**Appendix C**).

## Methods

Katzman (2003) collected water temperatures in three locations on mainstem Prospect Creek. Monitoring locations include: upstream of Cooper Gulch, 24 km upstream from the Prospect Creek mouth and upstream from Demont Creek, approximately 28.2 km upstream from Prospect Creek mouth. Based on the temperature data, Katzman concluded that Prospect Creek likely exceeds bull trout rearing temperatures at all locations on the main stem, particularly in the lower drainage where the maximum and average water temperatures were 63.3°F and 55.8°F respectively, between March and November of 2000 (RDG, 2004).

DEQ collected temperature data in 2002 and 2003. Data loggers were installed in mainstem Prospect Creek and major tributaries supporting bull trout including Clear, Cooper, Crow, Dry, Twentyfourmile, and Wilkes creeks. A list of temperature loggers, locations and years is included in **Table I-1**. Most data loggers were installed in the early or late part of July and removed in the end of September or early October. Instruments recorded water temperature at half hour intervals continuously each day. Data used for the summary statistics presented in the following figures and tables are complete through a periodicity of 24 hours and does not include partial days (i.e. data taken on the days of instrument installation or removal).

**Table I-1. Temperature Loggers in Prospect Creek Watershed**

| ID | YEAR | LOGGERID | STREAM_NAM | LOCATION_D | LAT | LONG |
|---|---|---|---|---|---|---|
| 1 | 2002 | 530221 | Cooper Creek | 1.5 mile up road #7623 | 47.526107 | -115.621807 |
| 2 | 2002 | 530222 | Crow Creek | above mouth, | 47.534530 | -115.552093 |
| 3 | 2002 | 530223 | Prospect Creek | above Crow, upstream of F.H. 7 bridge crossing and mouth of Crow Creek | 47.538470 | -115.545522 |
| 4 | 2002 | 530224 | Prospect Creek | above Coyote Creek, | 47.562738 | -115.455352 |
| 5 | 2002 | 530225 | Wilkes Creek | above trailhead | 47.540340 | -115.422047 |
| 6 | 2002 | 530226 | Prospect Creek | above Clear Creek, downstream of road #7618 bridge crossing | 47.576240 | -115.392525 |
| 7 | 2002 | 530227 | Clear Creek | mouth, downstream of F.H. 7 crossing | 47.576460 | -115.389657 |
| 8 | 2002 | 530228 | Clear Creek | above road #153 switchback, 9.3 miles from F.H. 7 | 47.612682 | -115.549730 |

**Table I-1. Temperature Loggers in Prospect Creek Watershed**

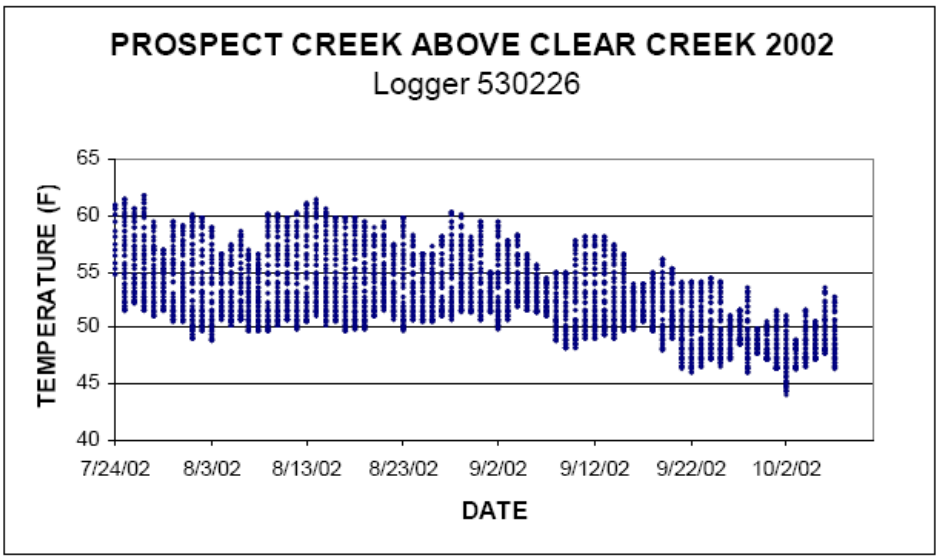
| ID | YEAR | LOGGERID | STREAM_NAM | LOCATION_D | LAT | LONG |
|---|---|---|---|---|---|---|
| 9 | 2002 | 530229 | East Fork Dry Creek | above Knox Creek, above CMP crossing at trailhead above Knox Creek mouth, in Section 6 | 47.525172 | -115.343587 |
| 10 | 2002 | 530230 | Dry Creek | mouth of Dry Creek at county road crossing | 47.585000 | -115.354600 |
| 11 | 2002 | 476524 | Know Creek | 200 feet above mouth of Knox Creek at Knox railhead | 47.524870 | -115.344162 |
| 12 | 2002 | 476522 | Twentyfour Mile Cre | above F.H 7 road crossing just above mouth | 47.576905 | -115.651978 |
| 13 | 2002 | 0 | West Fork Dry Creek | stolen in 2002, at Section 2 line with private, road #7614 | 47.528100 | -115.371838 |
| 0 | 2003 | 584788 | Prospect Creek | Prospect Creek above 24Mile Creek | 47.576520 | -115.653270 |
| 0 | 2003 | 584786 | Clear Creek | Clear Creek - Middle | 47.605040 | -115.446500 |

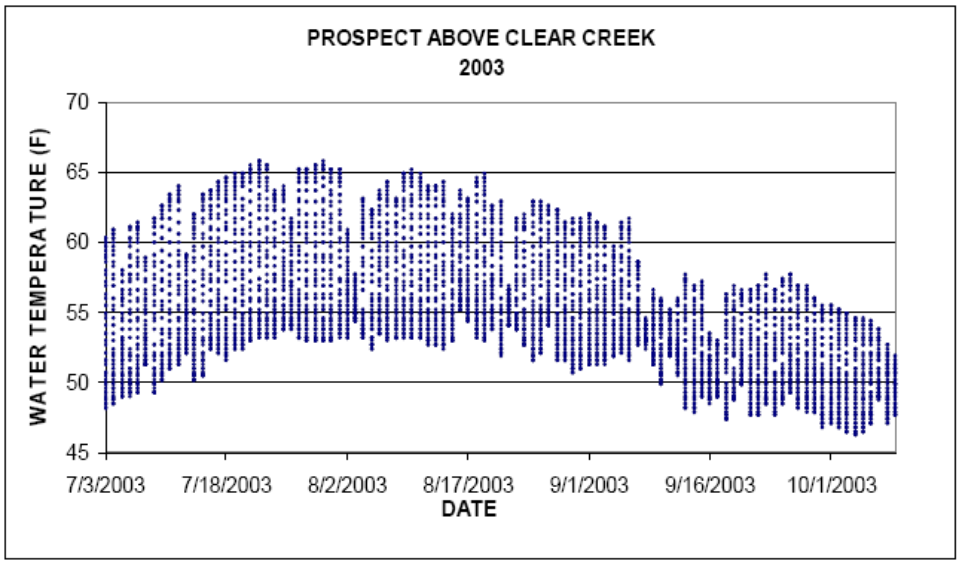
Riparian canopy density was measured for a sub-sample of locations on mainstem Prospect Creek using 1996 aerial photography. Methods are described in RDG 2004 and in **Appendix C**.

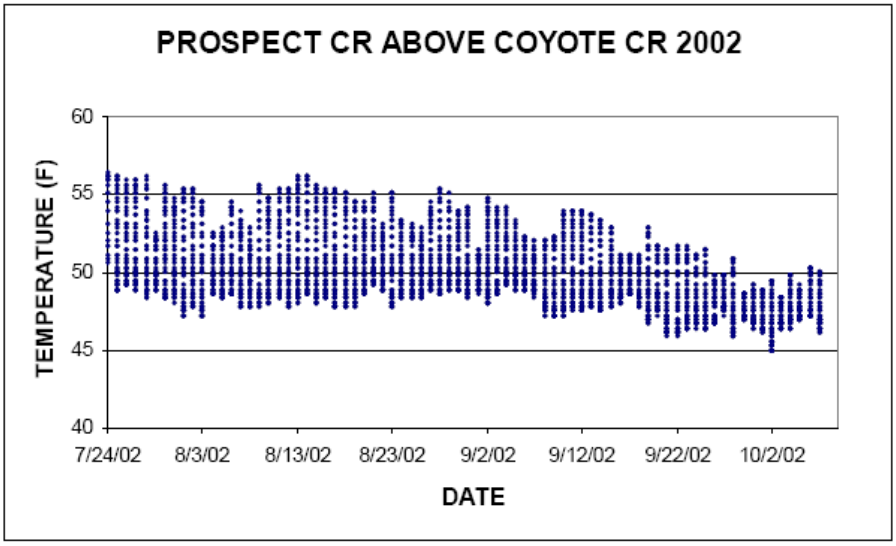
On August 30, 2005, Montana DEQ collected field measurements of riparian canopy density at some of the aerial photo sample sites using the EMAP method (Lazorchak, 2000). A densitometer was used to measure canopy shading the stream at three cross-sections within the aerial photo sample site. Cross sections were located in the middle of aerial photo sample site, at an upstream location within the site each site, and at a downstream location with the site. For each cross-section, a densitometer reading was taken at the left bank, the right bank, and in the middle of the channel. All readings were taken with the densitometer at 1 foot above the water surface,
All values were averaged to determine canopy density for the aerial photo site. (Lindgren, H., 2005)

## Results

The results of temperatures collected are presented in **Figures I-1 through I-7. Table I-1** summarizes temperature data from 2000 and 2003. Water temperatures for the main stem of Prospect Creek are compared to the canopy density analysis (**Appendix F**) in **Table I-2**.


PROSPECT CREEK ABOVE CLEAR CREEK 2002
Logger 530226
TEMPERATURE (F)
65
60
55
50
45
40
7/24/02
8/3/02
8/13/02
8/23/02
9/2/02
9/12/02
9/22/02
10/2/02
DATE


PROSPECT ABOVE CLEAR CREEK
2003
WATER TEMPERATURE (F)
70
65
60
55
50
45
7/3/2003
7/18/2003
8/2/2003
8/17/2003
9/1/2003
9/16/2003
10/1/2003
DATE



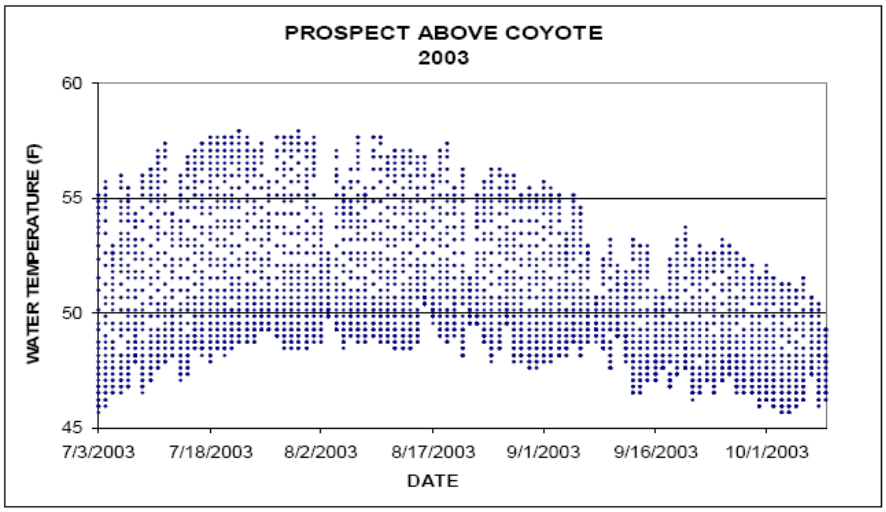
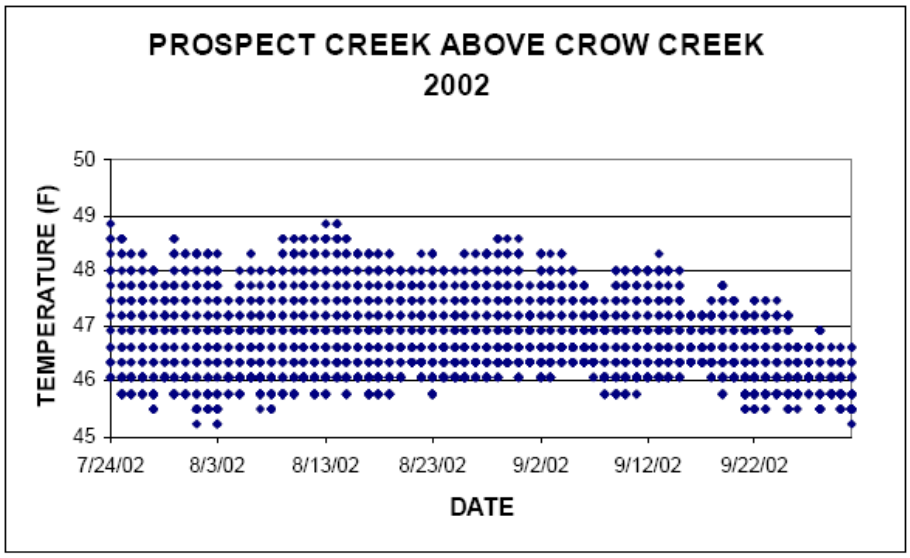
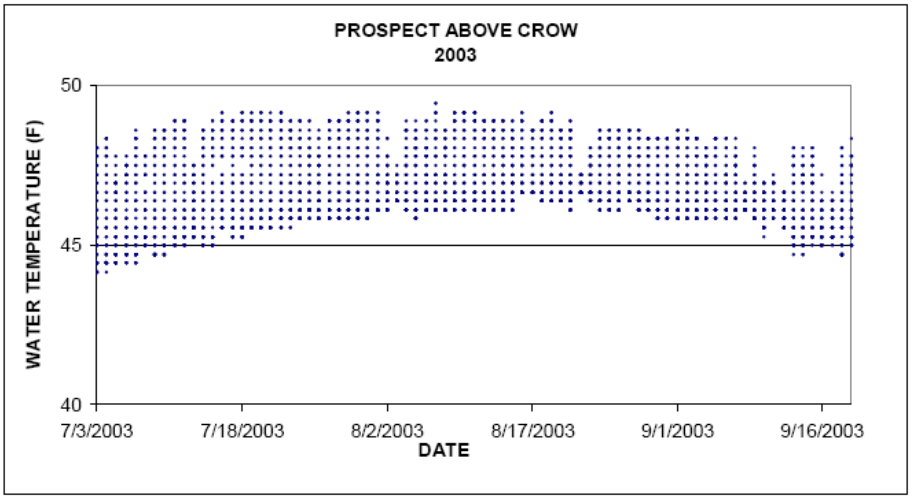




**Figure I-1. Range of Temperatures Recorded in a 24 Hour Period from July through October in Prospect Creek Watershed, 2002-2003***

*Top two charts present data from mainstem Prospect Creek, upstream of the mouth of Clear Creek.
*Bottom two charts present data from mainstem Prospect Creek, upstream of the mouth of Coyote Creek.
*Both sites are in Lower Prospect HUC 6.


PROSPECT CREEK ABOVE CROW CREEK
2002
TEMPERATURE (F)
50
49
48
47
46
45
7/24/02
8/3/02
8/13/02
8/23/02
9/2/02
9/12/02
9/22/02
DATE


PROSPECT ABOVE CROW
2003
WATER TEMPERATURE (F)
50
45
40
7/3/2003
7/18/2003
8/2/2003
8/17/2003
9/1/2003
9/16/2003
DATE

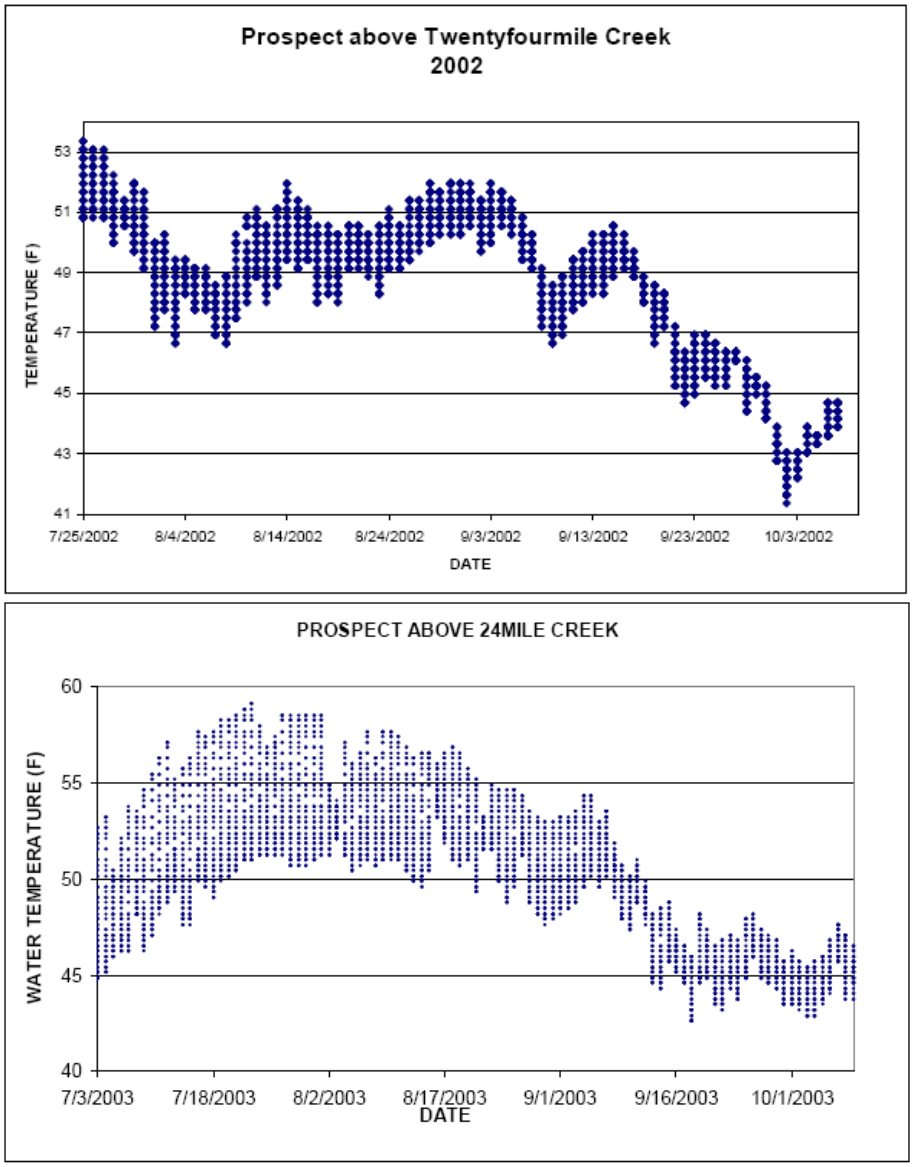
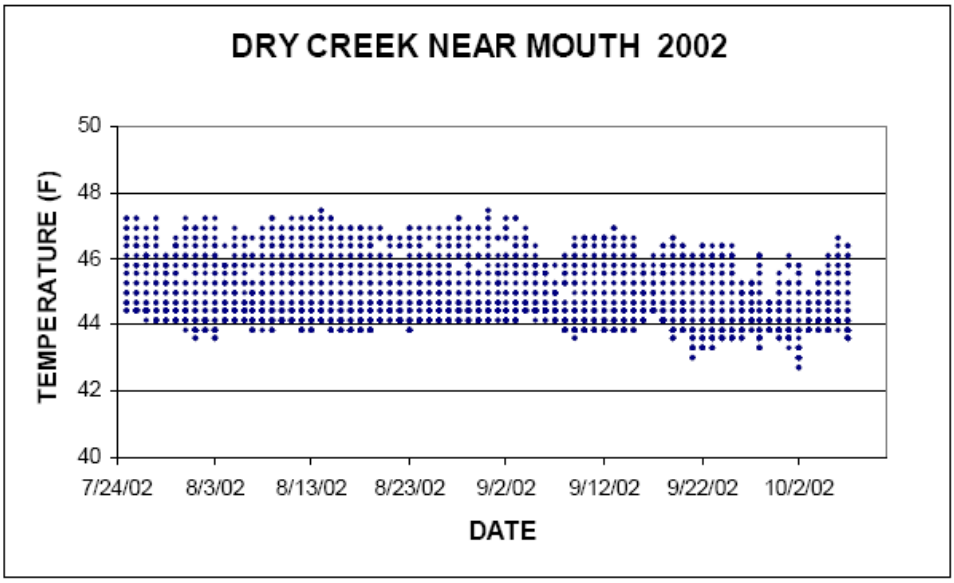
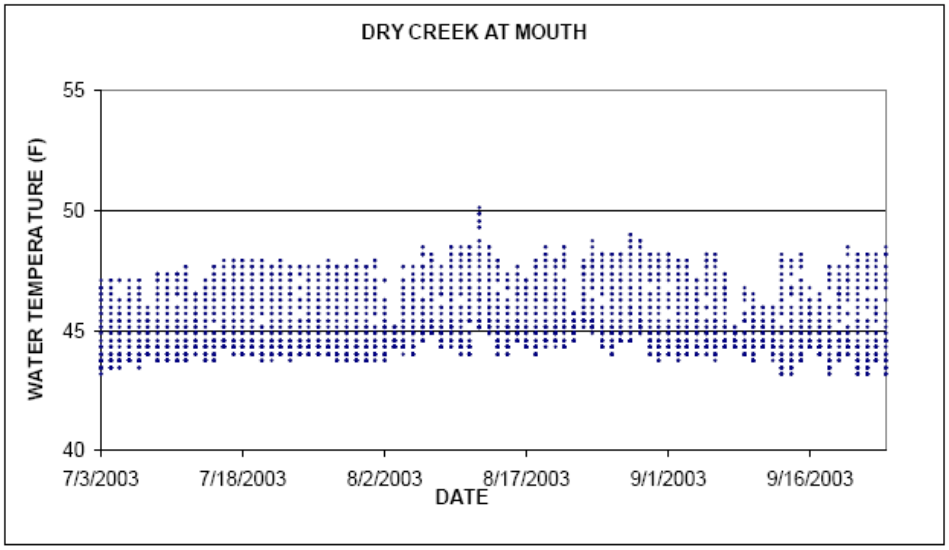



**Figure I-2. Range of Temperatures Recorded in a 24 hour Period from July through October in Prospect Creek Watershed, 2002-2003***

*Top two charts present data from mainstem Prospect Creek, upstream of Crow Creek, in Lower Prospect HUC 6.
*Bottom two charts present data from mainstem Prospect Creek, upstream of the mouth of Twentyfourmile Creek, in Upper Prospect HUC 6.


DRY CREEK NEAR MOUTH 2002
TEMPERATURE (F)
50
48
46
44
42
40
7/24/02
8/3/02
8/13/02
8/23/02
9/2/02
9/12/02
9/22/02
10/2/02
DATE


DRY CREEK AT MOUTH
WATER TEMPERATURE (F)
55
50
45
40
7/3/2003
7/18/2003
8/2/2003
8/17/2003
9/1/2003
9/16/2003
DATE

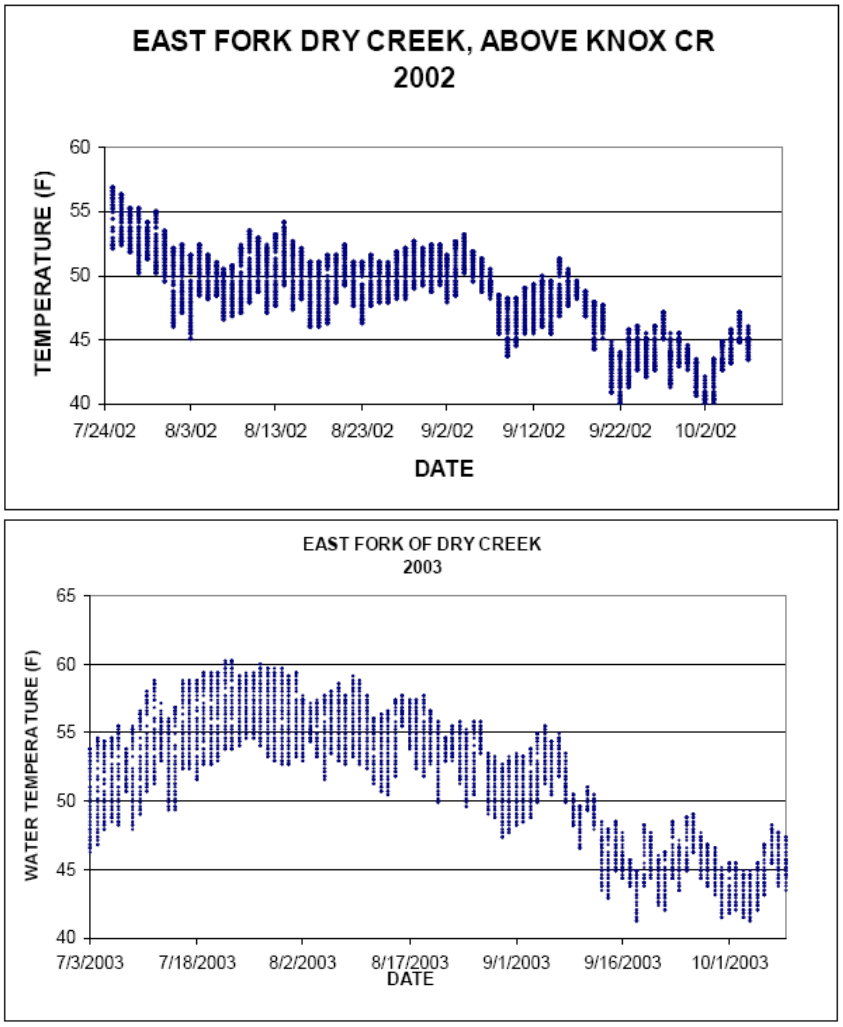
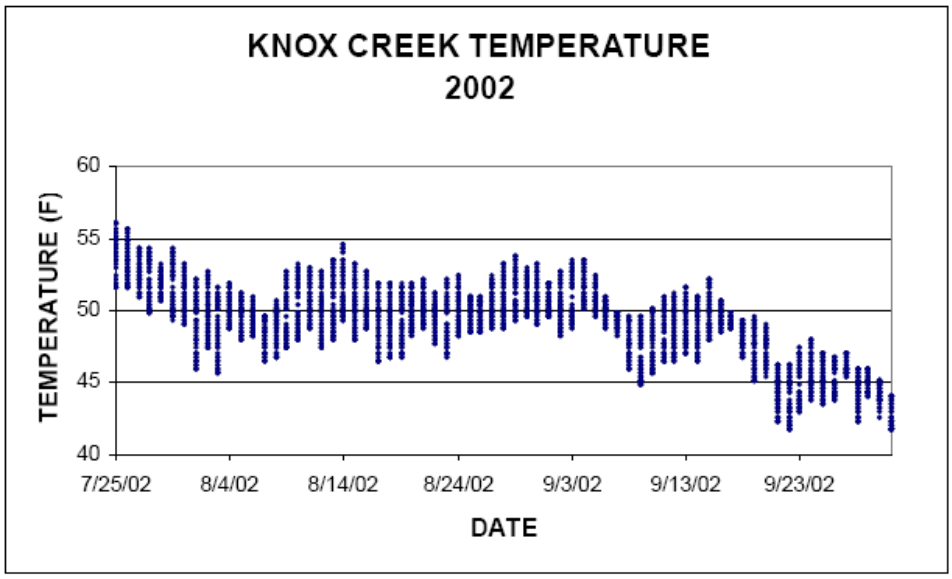


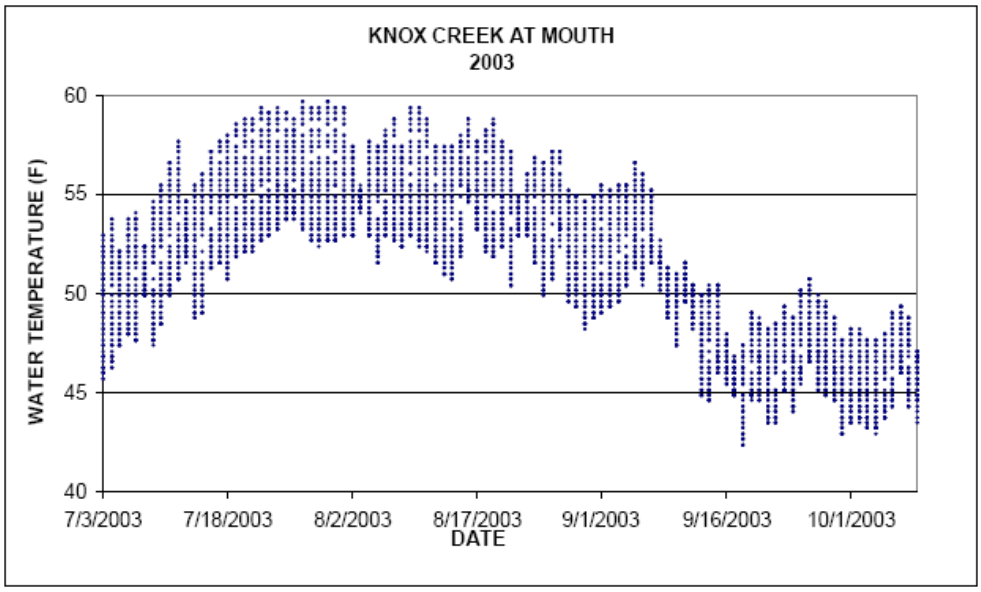

**Figure I-3. Range of Temperatures Recorded in a 24 Hour Period from July through October in Prospect Creek Watershed, 2002-2003***

*Top two charts present data from upstream of the mouth of Dry Creek.

*Bottom two charts present data from East Fork Dry Creek upstream of the mouth of Knox Creek.

*Both sites are in Dry Creek HUC 6.


KNOX CREEK TEMPERATURE
2002
TEMPERATURE (F)
60
55
50
45
40
7/25/02
8/4/02
8/14/02
8/24/02
9/3/02
9/13/02
9/23/02
DATE


KNOX CREEK AT MOUTH
2003
WATER TEMPERATURE (F)
60
55
50
45
40
7/3/2003
7/18/2003
8/2/2003
8/17/2003
9/1/2003
9/16/2003
10/1/2003
DATE

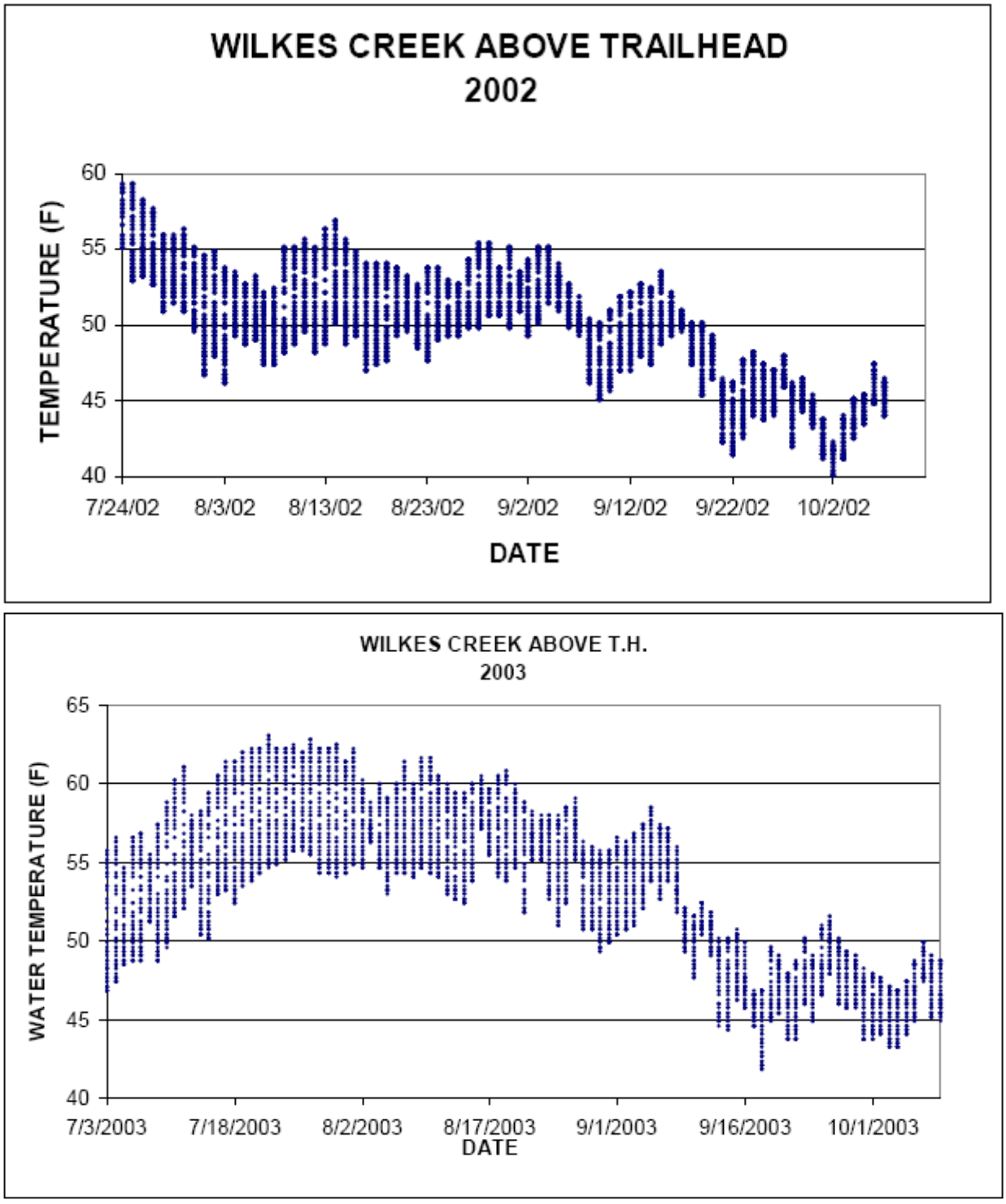
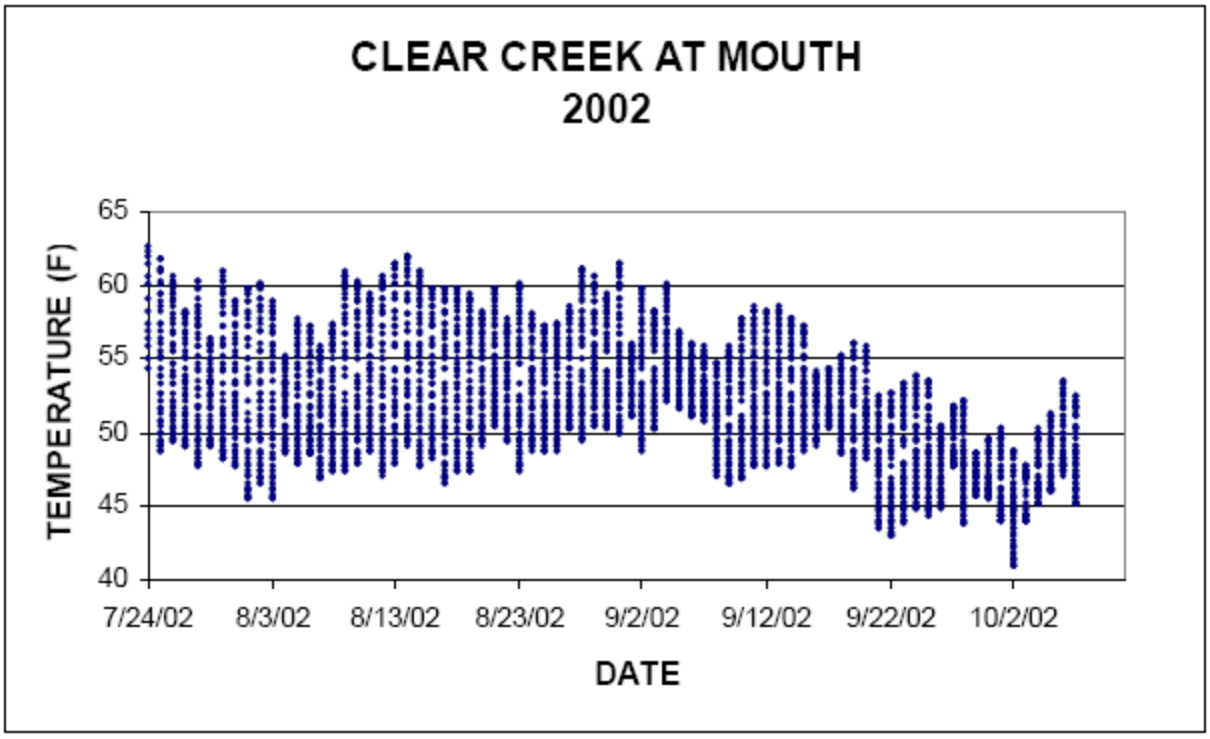
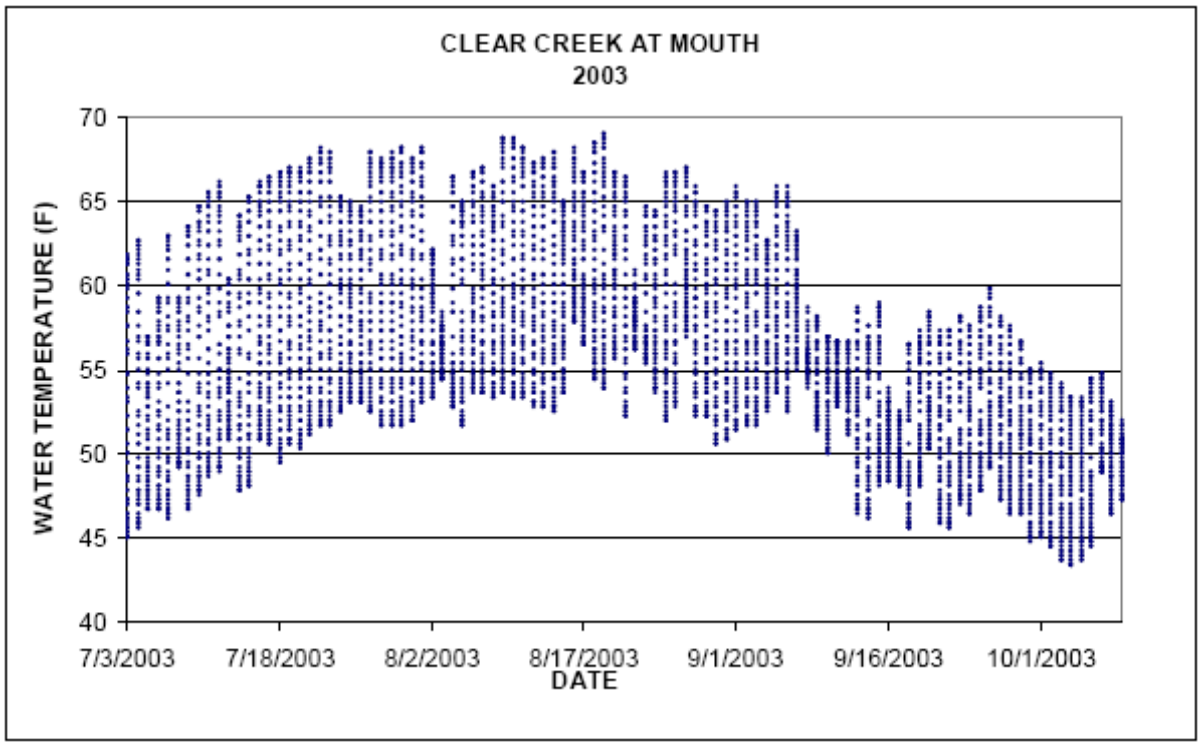
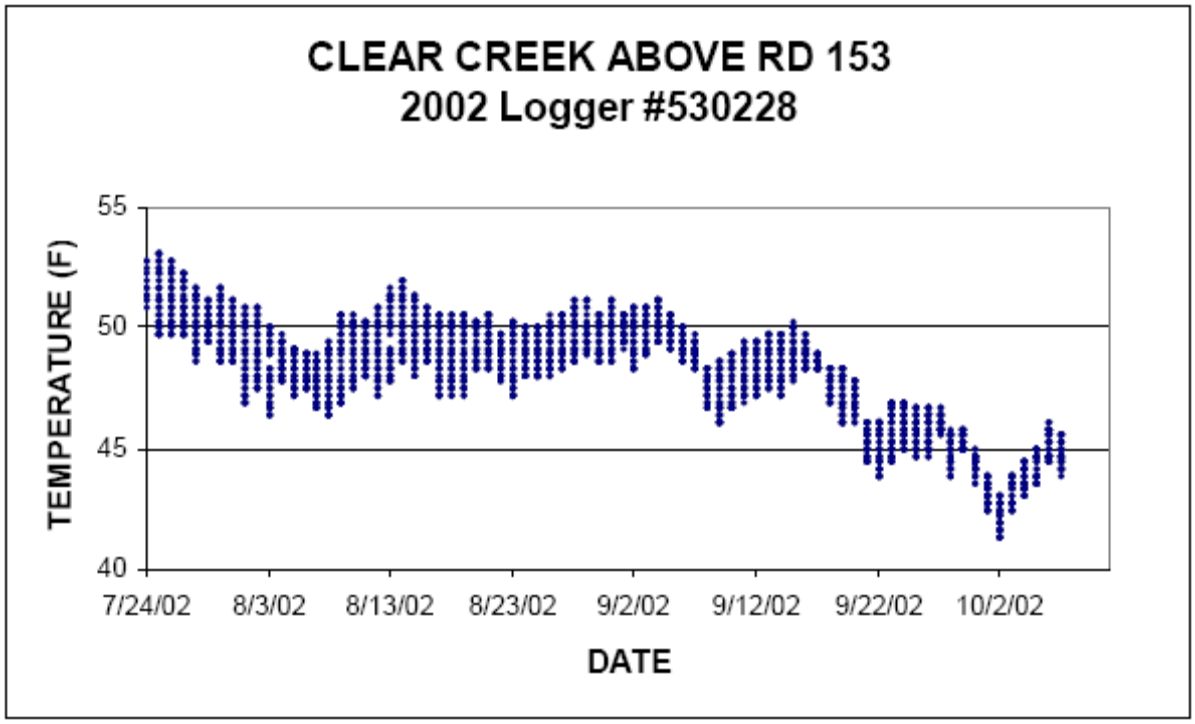



**Figure I-4. Range of Temperatures Recorded in a 24 Hour Period from July through October in Prospect Creek Watershed, 2002-2003**

Top two charts present data from upstream of the mouth of Knox Creek in Dry HUC 6.
Bottom two charts present data from Wilkes Creek above the trailhead in Wilkes HUC 6.


CLEAR CREEK AT MOUTH
2002
TEMPERATURE (F)
65
60
55
50
45
40
7/24/02
8/3/02
8/13/02
8/23/02
9/2/02
9/12/02
9/22/02
10/2/02
DATE


CLEAR CREEK AT MOUTH
2003
WATER TEMPERATURE (F)
70
65
60
55
50
45
40
7/3/2003
7/18/2003
8/2/2003
8/17/2003
9/1/2003
9/16/2003
10/1/2003
DATE



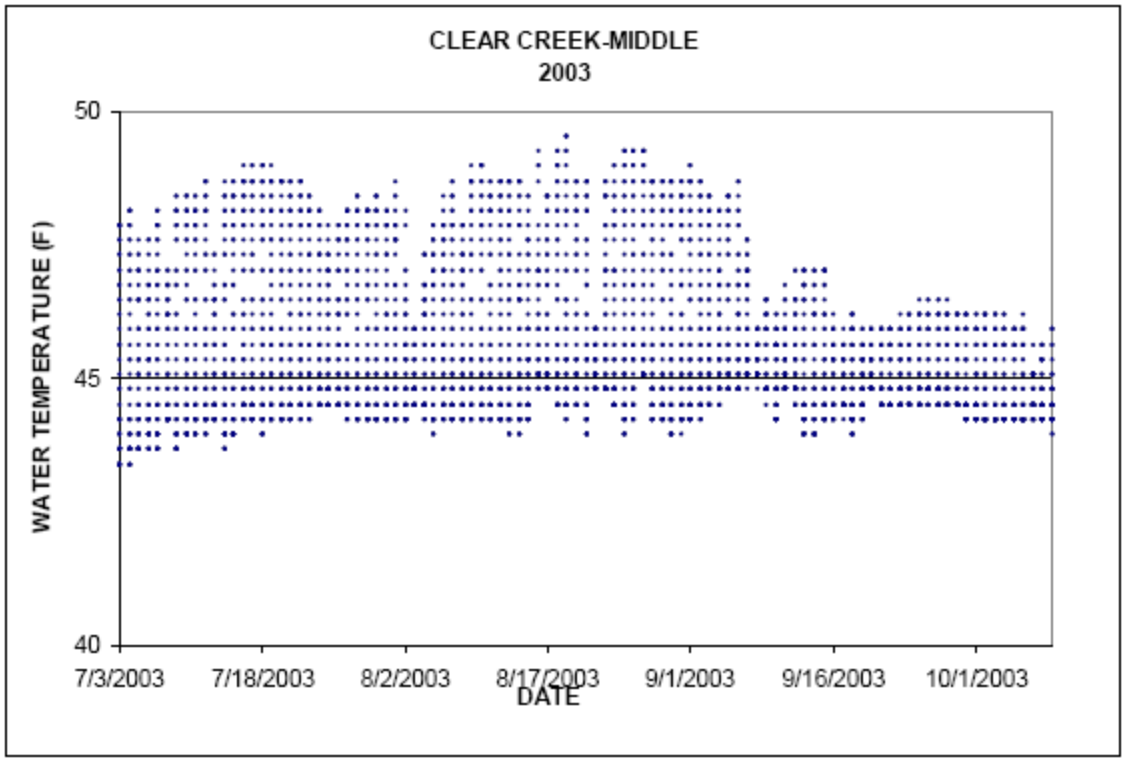
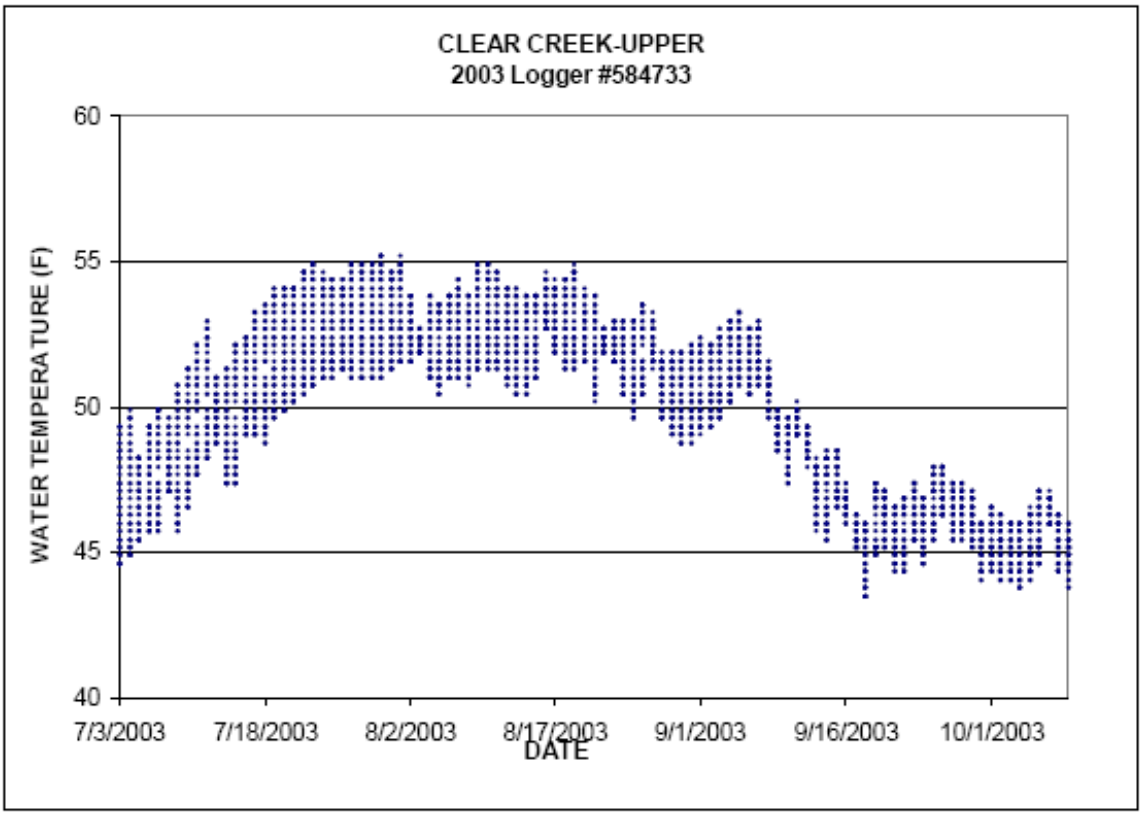
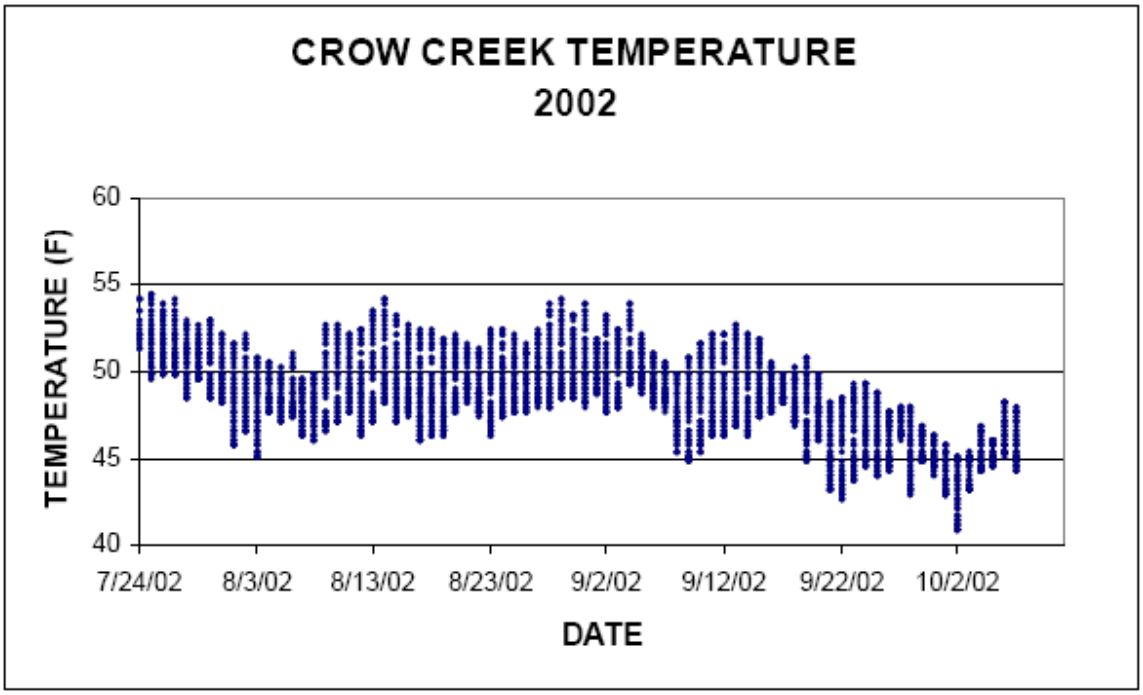




**Figure I-5. Range of Temperatures Recorded in a 24 Hour Period from July through October in Prospect Creek Watershed, 2002-2003**

Top two charts present data from Clear Creek near the mouth.
Bottom left chart presents data from Clear Creek above forest road 153 in 2002.
Bottom right chart presents data from the middle Clear Creek site in 2003.
All sites are in Clear HUC 6.


CLEAR CREEK-UPPER
2003 Logger #584733
WATER TEMPERATURE (F)
60
55
50
45
40
7/3/2003
7/18/2003
8/2/2003
8/17/2003
9/1/2003
9/16/2003
10/1/2003
DATE


CROW CREEK TEMPERATURE
2002
TEMPERATURE (F)
60
55
50
45
40
7/24/02
8/3/02
8/13/02
8/23/02
9/2/02
9/12/02
9/22/02
10/2/02
DATE

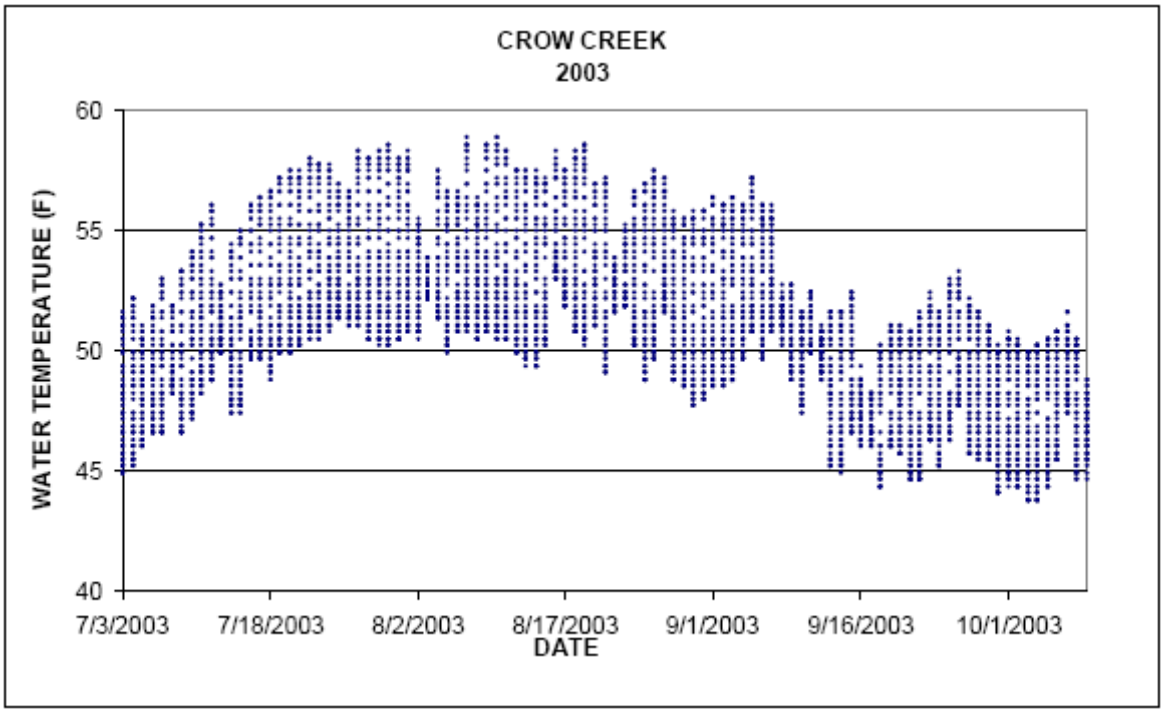
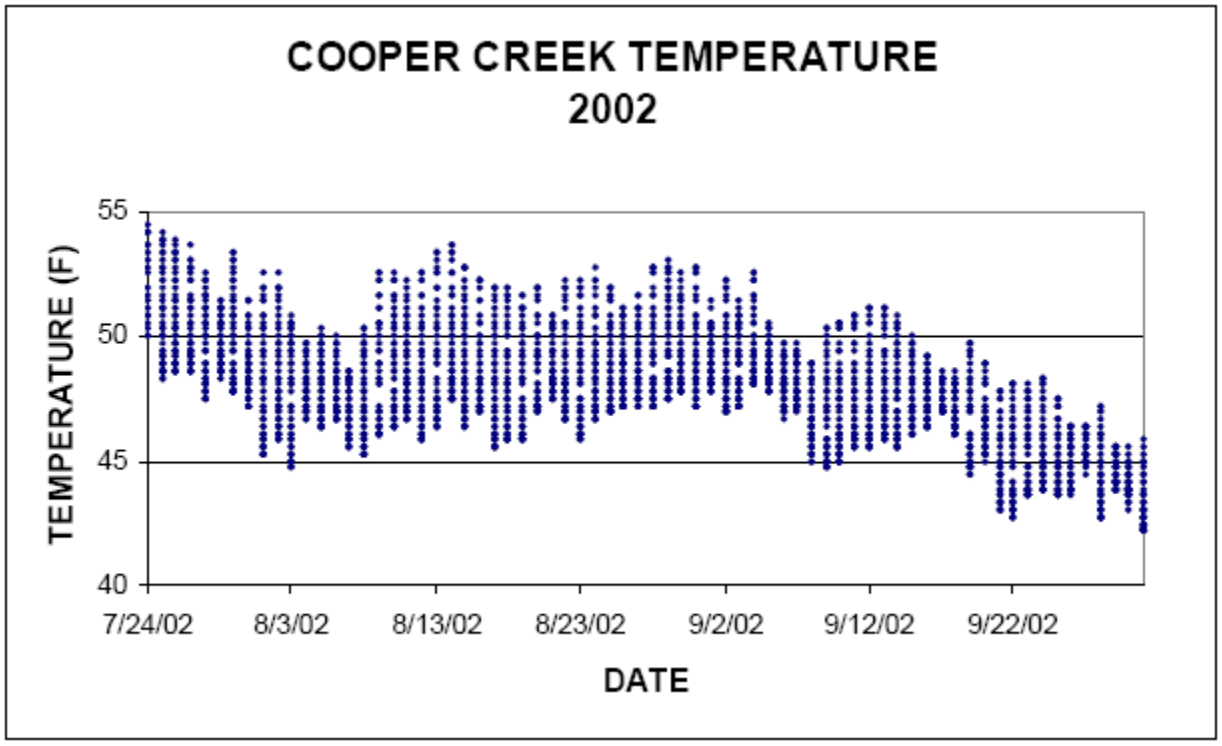
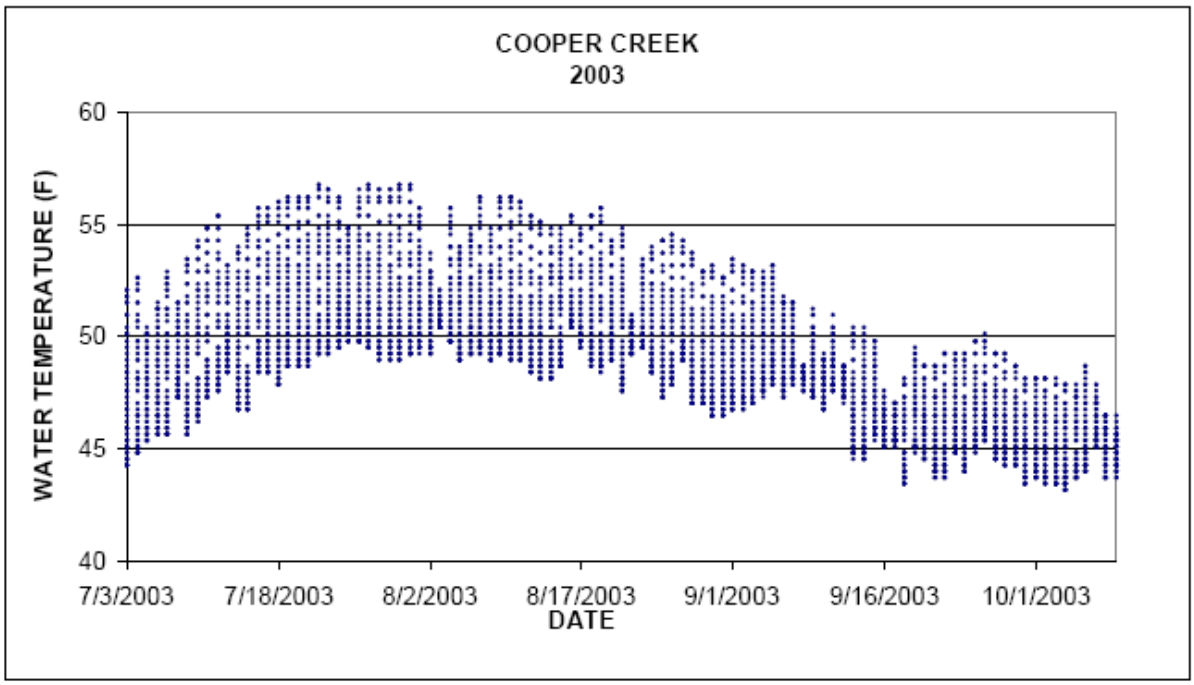
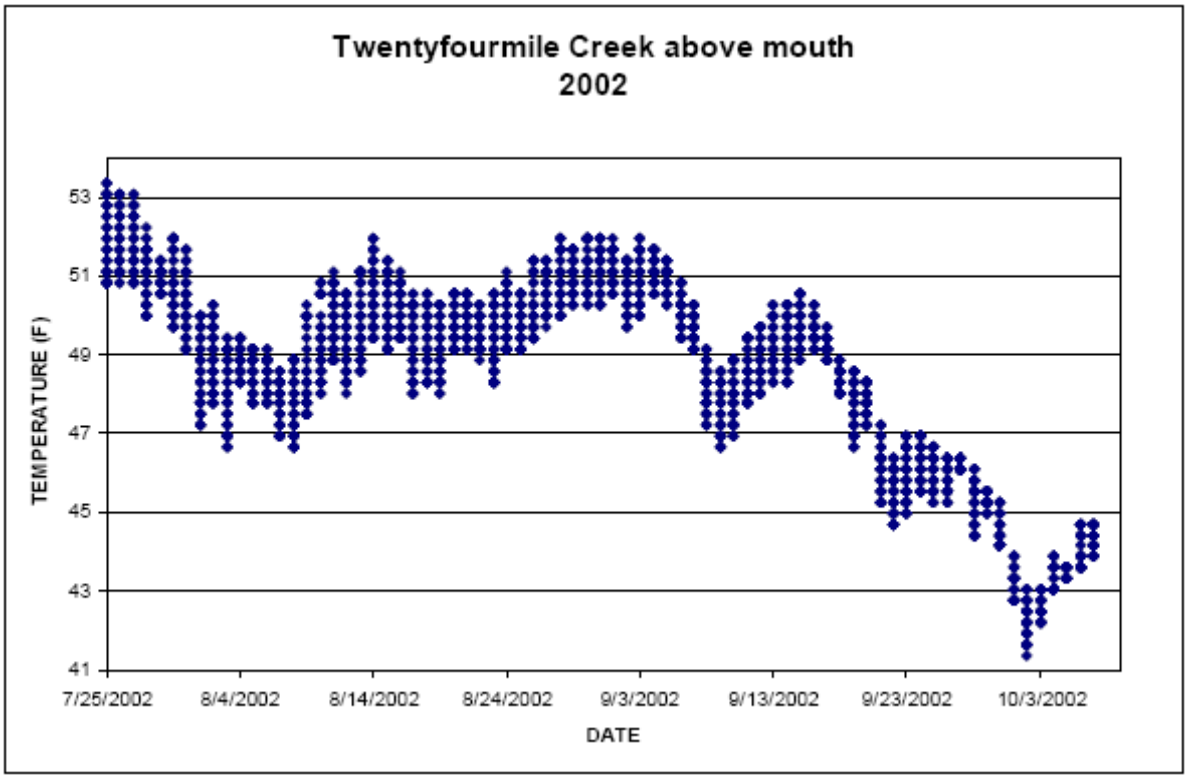



**Figure I-6. Range of Temperatures Recorded in a 24 Hour Period from July through October in Prospect Creek Watershed, 2002-2003**
Top left chart presents data from Upper Clear Creek in Clear HUC 6.
Bottom two charts present data from upstream of the mouth of Crow Creek in Crow HUC 6.




COOPER CREEK
2003
WATER TEMPERATURE (F)
60
55
50
45
40
7/3/2003
7/18/2003
8/2/2003
8/17/2003
9/1/2003
9/16/2003
10/1/2003
DATE


Twentyfourmile Creek above mouth
2002
TEMPERATURE (F)
53
51
49
47
45
43
41
7/25/2002
8/4/2002
8/14/2002
8/24/2002
9/3/2002
9/13/2002
9/23/2002
10/3/2002
DATE

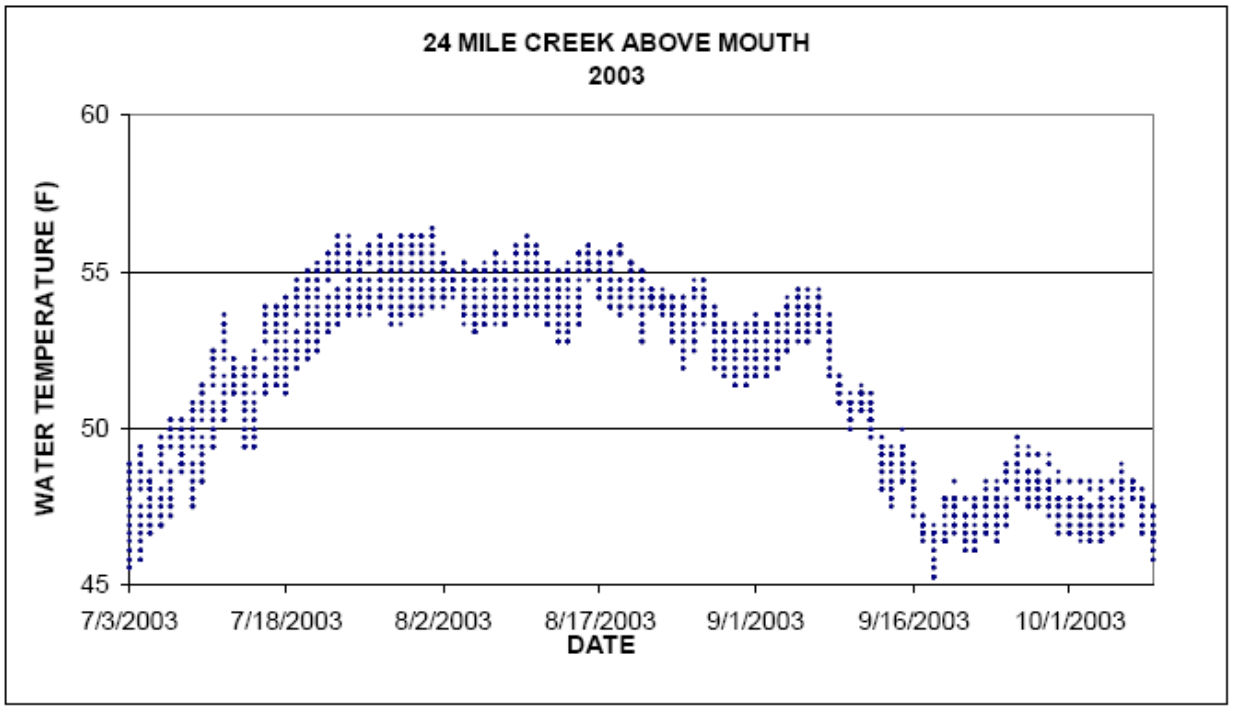



**Figure I-7. Range of Temperatures Recorded in a 24 Hour Period from July through October in Prospect Creek Watershed, 2002-2003**

Top two charts present data from upstream of the mouth of Cooper Creek in Cooper HUC 6.
Bottom two charts present data from upstream of the mouth of Twentyfourmile Creek in Upper Prospect HUC 6.

**Table I-2. Summary of DEQ Temperature Data in Prospect Creek Watershed**

| Serial Number | Location | Start Date | Stop Date | Maximum of 7-Day Ave. Temps. (°F) | Max. 7-Day Ave. Date | Days >54° F* | Days >59° F* |
|---|---|---|---|---|---|---|---|
| 530223 | Prospect above Crow Cr | 7/25/02 | 10/7/02 | 48.7 | 8/12/02 | 0 | 0 |
| 530224 | Prospect above Coyote Cr | 7/25/02 | 10/7/02 | 55.7 | 8/14/02 | 28 | 0 |
| 530226 | Prospect above Clear Cr | 7/25/02 | 10/7/02 | 60.5 | 8/12/02 | 61 | 25 |
| 476524 | Knox Cr at the mouth | 7/26/02 | 10/6/02 | 53.9 | 7/29/02 | 5 | 0 |
| 530221 | Cooper Creek 1.5 mi up Rd 7623 | 7/25/02 | 10/7/02 | 52.9 | 7/28/02 | 1 | 0 |
| 530222 | Crow Cr above the mouth | 7/25/02 | 10/7/02 | 53.3 | 7/28/02 | 4 | 0 |
| 530228 | Clear Cr above Rd 153 | 7/25/02 | 10/6/02 | 51.9 | 7/28/02 | 0 | 0 |
| 230227 | Clear Cr at the mouth | 7/25/02 | 10/7/02 | 60.8 | 8/12/02 | 58 | 25 |
| 530229 | E F Dry Creek above Knox Cr | 7/26/02 | 10/7/02 | 54.5 | 7/29/02 | 6 | 0 |
| 530230 | Dry Creek near the mouth | 7/26/02 | 10/7/02 | 47.2 | 8/12/02 | 0 | 0 |
| 530225 | Wilkes Cr above Trail Head | 7/25/02 | 10/7/02 | 57.0 | 7/28/02 | 27 | 1 |
| 476522 | 24 Mile Cr Above Mouth | 7/3/03 | 10/9/03 | 56.1 | 07/29/03 | 44 | 0 |
| 476524 | Knox Creek At Mouth | 7/3/03 | 10/9/03 | 59.4 | 07/29/03 | 62 | 12 |
| 584731 | E Fork of Dry Creek | 7/3/03 | 10/9/03 | 59.7 | 07/25/03 | 58 | 15 |
| 584732 | Dry Creek At Mouth | 7/3/03 | 9/24/03 | 48.5 | 08/10/03 | 0 | 0 |
| 584733 | Clear Creek Upper | 7/3/03 | 10/9/03 | 54.9 | 07/29/03 | 24 | 0 |
| 584786 | Clear Creek-Middle | 7/3/03 | 10/9/03 | 49.0 | 08/27/03 | 0 | 0 |
| 584787 | Clear Creek At Mouth | 7/3/03 | 10/9/03 | 67.8 | 08/11/03 | 93 | 66 |
| 584788 | Prospect Above 24Mile Creek | 7/3/03 | 10/9/03 | 58.4 | 07/29/03 | 51 | 1 |
| 584789 | Cooper Creek | 7/3/03 | 10/9/03 | 56.5 | 07/29/03 | 44 | 0 |
| 584806 | Crow Creek | 7/3/03 | 10/9/03 | 58.0 | 07/29/03 | 57 | 0 |

**Table I-2. Summary of DEQ Temperature Data in Prospect Creek Watershed**

| Serial Number | Location | Start Date | Stop Date | Maximum of 7-Day Ave. Temps. (°F) | Max. 7-Day Ave. Date | Days >54° F* | Days >59° F* |
|---|---|---|---|---|---|---|---|
| 584807 | Prospect Above Crow | 7/3/03 | 9/19/03 | 49.1 | 07/19/03 | 0 | 0 |
| 584846 | Prospect Above Coyote | 7/3/03 | 10/9/03 | 57.7 | 07/20/03 | 62 | 0 |
| 584847 | Wilkes Creek Above T.H. | 7/3/03 | 10/9/03 | 62.5 | 07/25/03 | 68 | 39 |
| 58489 | Prospect Above Clear Creek | 7/3/03 | 10/9/03 | 65.1 | 07/20/03 | 94 | 62 |
| * Absolute total number of days where temperature exceeded the threshold. | | | | | | | |

**Table I-3. Comparison of Water Temperatures and Canopy Density Analysis in Main Stem Prospect Creek**

| Temp. Serial Number | Temp. Sample Location | Temp. Date | Reach | Nearby Cross Section (2003) | Width-to-Depth (2003) | Canopy Density Analysis Site+ | Maximum of 7-Day Temp. Averages (°F) | Days >54° F* | Days >59° F* | Average % Riparian Canopy Density+ | Average % Riparian Canopy Density$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 530226 | Prospect above Clear Cr | 2002 | 2 | RDG XS 3 | 36.2 | 3 – 5 | 60.5 | 61 | 25 | 32 | 8 |
| 58489 | Prospect Above Clear Creek | 2003 | 2 | RDG XS 3 | 36.2 | 3 – 5 | 65.1 | 94 | 62 | 32 | 8 |
| 530224 | Prospect above Coyote Cr | 2002 | 3 | RDG XS 1 | 30.4 | 5 – 7 | 55.7 | 28 | 0 | 50 | -- |
| 584846 | Prospect Above Coyote | 2003 | 3 | RDG XS 1 | 30.4 | 5 – 7 | 57.7 | 62 | 0 | 50 | -- |
| 530223 | Prospect above Crow Cr | 2002 | 3 | RDG XS 2 | 319.1 | 27– 29 | 48.7 | 0 | 0 | 58 | -- |
| 584807 | Prospect Above Crow | 2003 | 3 | RDG XS 2 | 319.1 | 27– 29 | 49.1 | 0 | 0 | 58 | -- |
| 584788 | Prospect Above 24Mile Creek | 2003 | 5 | LNF | 26.6 | 20-22 | 58.4 | 51 | 1 | 59 | -- |

* Absolute total number of days where temperature exceeded the threshold.

+ As measured and described in RDG 2004.

$ DEQ field verification 2005 using densiometer and EMAP methods.

## Discussion

Several factors influence stream temperatures including land management, canopy density, groundwater discharge, precipitation, and seasonality. Historic and present impacts in the Prospect Creek watershed affect stream temperature in Prospect Creek. Wildfires, flooding, road construction, and bank stabilization efforts have contributed to increased channel width throughout mainstem Prospect Creek in reaches 2 through 4. Riparian clearing, riparian grazing, and floodplain development have negatively impacted stream shading by decreasing vegetation density and species diversity. Decreases in canopy density and increases in overall channel width equate to less stream surface shade and higher stream temperatures, especially in the lower watershed.

In **Table I-3**, an increase in canopy density generally correlates to a decrease in water temperatures

## References

Katzman, L. 2003. Prospect Creek Westslope Cutthroat Trout and Bull Trout Life History Study – Final Report – 2000. Fish Passage/Native Salmonid Restoration Program, Appendix C. Noxon, Montana: Montana Fish, Wildlife and Parks and Avista Corporation.

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